Aspects of Integral Risk Management in Practice – Considerations with Respect to Mountain Hazards in Switzerland

Integrales Risiko Management in der Praxis – Bemerkungen zum Umgang mit Naturgefahren in der Schweiz

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SUMMARY/KURZFASSUNG

All types of planning that involve land use (e.g. settlements, industry, roads and other infrastructure) should not only evaluate the potential for use provided by the environment but also the potential for dangers and risks originating from the environment. In focusing on natural risks, an ideal procedure starts with comprehensive risk assessment, including risk analysis and risk valuation, on the basis of which preventive and mitigation measures, including preparation for disaster event management, must be carried out. In the case of an emergency or disaster the intervention services have to cope with the event and to start restoration afterwards. In the subsequent phase of regeneration the primary goal of reconstruction must unquestionably be accompanied by efforts to learn from recent experience and by optimization of risk prevention. This makes it possible to "raise each procedure to a higher level of performance", turning the risk management cycle into an ascendant risk management spiral. All these activities require good coordination between the various players, participants and stakeholders involved, making communication and information a key factor in every phase.

Bei jedem Vorhaben, das Raumnutzung (z. B. für Siedlung, Industrie, Infrastruktur, Verkehrswege usw.) impliziert, sollte nicht nur das Nutzungspotential bekannt sein, welches das natürliche Umfeld gewährt, sondern auch das Naturgefahrenpotential im genutzten Umfeld und die daraus resultierenden Risiken. Ein sinnvolles und logisches Vorgehen gegenüber Naturgefahren beginnt mit einer umfassenden Gefahren- und Risikobeurteilung. Auf dieser Grundlage können präventive Maßnahmen geplant und implementiert sowie die notwendigen Vorsorgemaßnahmen für den Einsatz im Ereignisfall an die Hand genommen werden. Im Ereignisfall werden die Interventionskräfte aktiv und leiten nach den Rettungseinsätzen die Instandstellung ein. In der darauf folgenden Regenerationsphase gilt es nicht zuletzt auch, aus den Erfahrungen zu lernen und die Prävention und Vorsorgemaßnahmen für zukünftige Ereignisse zu optimieren. Dadurch können die verschiedenen Prozeduren im Rahmen eines umfassenden Risikomanagements sozusagen auf ein höheres Niveau angehoben werden: Aus dem Risiko-Management-Zyklus wird somit eine ansteigende Spirale. Alle diese Tätigkeiten erfordern eine gute Koordination zwischen den verschiedenen AkteurInnen, Betroffenen und weiteren Interessierten. In jeder Phase sind folglich Kommunikation und Information Schlüsselfaktoren.

1. NATURAL HAZARDS AND RISKS

The natural hazards considered here are defined as potentially damaging processes resulting from the movement of water, snow, ice, debris and rocks on the surface of the earth. This includes snow avalanches, floods, debris flows, rock falls and landslides. These hazards are inherent in the nature of mountainous regions and may occur with a specific magnitude and frequency in a given region.

Many losses due to disaster, rather than stemming from unexpected events, are the predictable result of interactions between the physical environment, which includes hazardous events on the one hand and the human system on the other. A sustainable modern strategy in dealing with mountain hazards should therefore be directed towards comprehensive risk management. This strategy requires systematic approaches both in planning and in realizing concepts and measures. General risk management includes two main categories:

- prevention and mitigation strategies, and
- event and post-event management (including their preparation).

2. DEALING WITH NATURAL RISKS: "WHAT SECURITY AT WHAT PRICE?"

In 1987 various natural disasters affected Switzerland and neighboring regions, and consequently the year became a turning point in dealing with natural risks. The previous impression of absolute security proved to be an illusion; the belief in progress and the feasibility of all desired measures was deeply and widely shaken. While experts had already initiated discussions about the acceptability of risks, and about differentiation between necessary and desirable measures in the late 1970s, after 1987 the general public also started to pay much more attention to those issues. The population had almost tacitly expected the authorities to eliminate the dangers or at least to manage them fully. However more recently some discussions have started about: What to protect ? What amount of money to spend for protection and mitigation? In times of strained budgets this implies a large potential for conflict!

In the phase of reconstruction at the latest, the questions that regularly emerge are: "What security at what price? What residual risks are to be accepted ?" In dealing with natural risks, therefore, a change in philosophy has been proposed, namely, "from defending against danger to being aware of Risks". Consequently in dealing with natural risks a change in philosophy has been proposed, namely, "from defending against dange to being aware of risks". This new "risk culture" means dealing with risks through comprehensive risk management, considering social, economic and ecological demands from a perspective of sustainability.

3. THE RISK MANAGEMENT CYCLE

In an ideal procedure individuals or societies who are starting or expanding any kind of activity (i.e. land-use for any purpose such as settlement, industry, infrastructure, connections, etc.) should not only evaluate the potential provided by the environment but also the potentially inherent dangers and risks. Besides natural risks, technical and societal risks must also be taken into consideration.

To concentrate on natural risks, the ideal procedure starts with comprehensive risk assessment, including risk analysis and risk valuation. On this

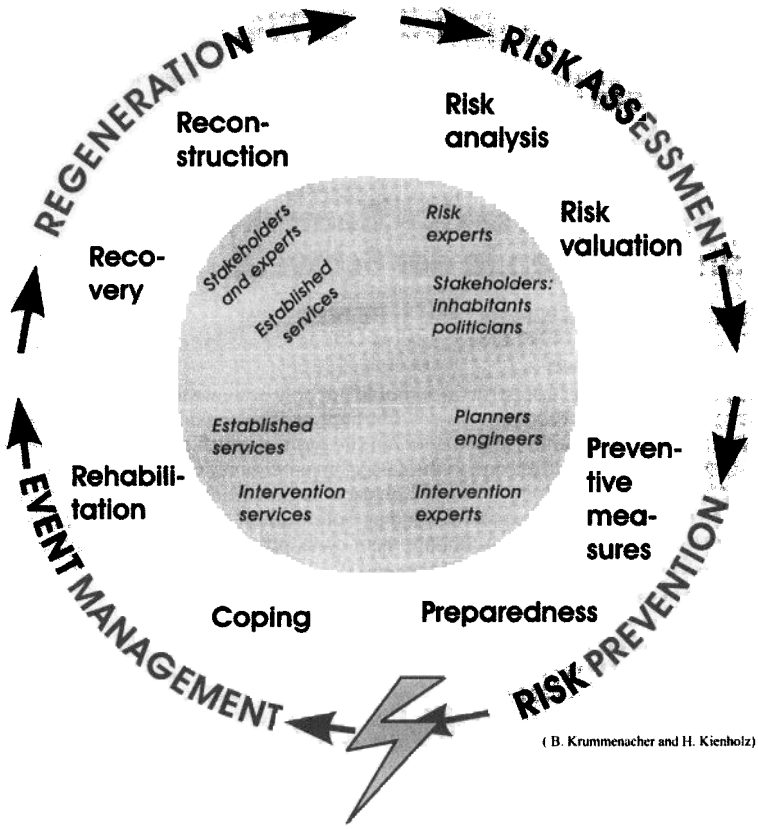

Fig. 1. The risk management cycle

basis the preventive and mitigative measures and all the activities represented in Fig. 1 can be carried out or prepared for.

While such a risk management cycle can be considered to provide the theoretical background and as such to be universal, it usually has to be applied in practice to a specific system defined by its own characteristics (thematic, spatial, temporal, conditional, etc.). Therefore in a specific case (i.e. natural risk management within a given municipality) the system and its parameters have to be clearly defined before it is possible to pass through the steps in the four fields of action shown in Fig. 1. Having this in mind the following considerations mainly focus on the municipal level and on the situation in Switzerland.

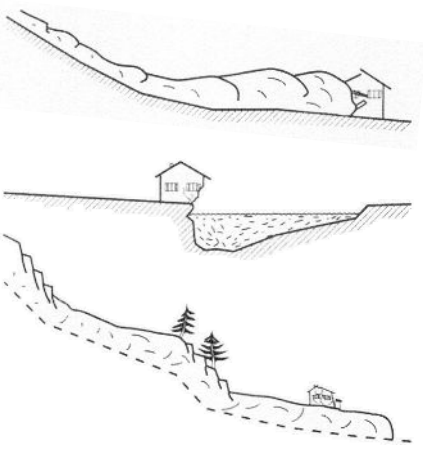

Fig. 2. Types of impact by mountain hazard processes

3.1 Risk assessment (1st field of action according to Fig. 1)

Risk assessment includes both risk analysis and risk valuation within a defined system. In this context the scales (spatial, temporal, degree of detail) must also be well defined.

Risk analysis

The general goal of any risk analysis is to answer the question "what could happen?" While the hazard analysis concentrates on natural or quasi-natural processes (i.e. debris flows, rock falls, snow avalanches, floods, etc.) a risk analysis additionally includes qualitative and quantitative considerations of the assets at risk, their exposure and vulnerability (see Table 1).

The results of the risk analysis for a defined system in the context of natural hazards include statements about

- the types of hazardous processes involved, their intensity (magnitude) and frequency, and possibly the mode of impact on objects (cf. Fig. 2);
- the assets at risk (human lives, immobile and mobile objects) and their monetary, direct or indirect economic values, including their ecological and also immaterial value, their function (i.e. lifelines, infrastructure, etc.), with their exposure and vulnerability as to a given hazard scenario;
- and derived from the above findings, the probable consequences of any possible damaging or disastrous event.

The analyses must be performed on the basis of scientific methods (cf. Fig. 3) in order to obtain qualitative and – as far as possible and meaningful – quantitative, objectively verifiable statements. Risk analysis accordingly is clearly the task of experts and/or interdisciplinary expert teams (cf. e.g. KIENHOLZ et al., 2002). In spite of the uncertainties involved even in well performed risk analyses and despite the chaotic character of natural and human systems, the carefully elaborated statements should be considered more or less as facts that serve as a basis for further steps in risk management.

The major participants and players in the phase of risk analysis are experts who are familiar with the hazardous processes, the related analysis methods, and with the vulnerability of objects. Because this task involves various generally quite difficult topics, this task should be performed by teams of professionals with different specific backgrounds.

Risk valuation

Risk valuation is the process of "characterizing" risks for subsequent decision-making. Socioeconomic information as well as risk perception and risk valuation by decision makers and affected stakeholders, is important. The goal of risk valuation is to answer the question "what loss is acceptable; what could be permitted to happen?" These questions can only be answered by the stakeholders concerned on the basis of their risk perception and awareness. Perception and awareness are highly influenced by factors like experience of life, personal and societal value system, or living standard. In addition, aversion to risks plays an important role; e.g. 100 acci-

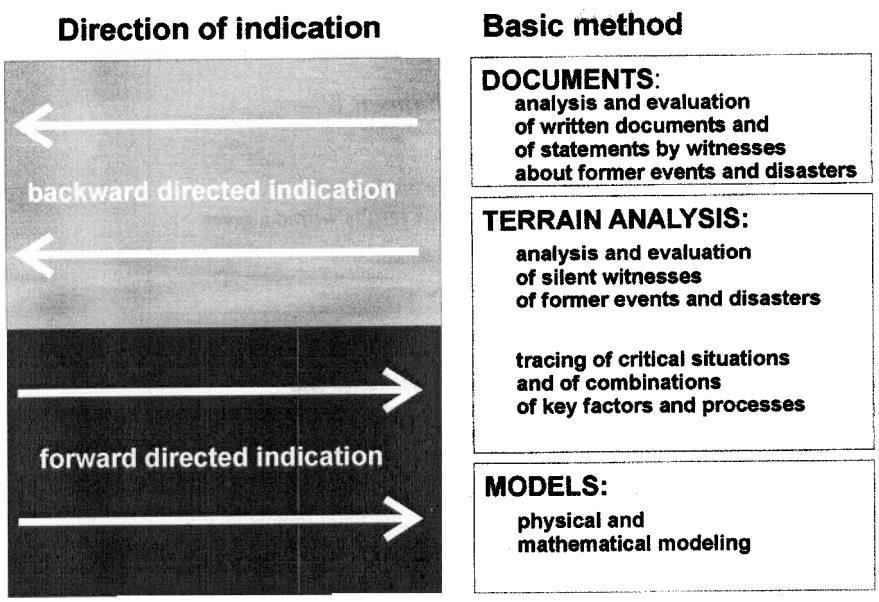

Fig. 3. Basic methods of hazard analysis

dents with 1 person killed per year may be better accepted than 1 accident with 100 persons killed per year. "This means that incidents involving massive damage as well as disasters are perceived and rated much more hazardous than frequent incidents or accidents causing relatively minor damage" (cf. BABS, 2002). Furthermore, voluntary risks are better accepted than non-voluntary risks and indirect risks. A tourist resort's risk of losing its reputation due to natural hazards has to be evaluated too. Finally the risks related to any action or land use are weighed against the related benefits.

Risk valuation is clearly the duty of the stakeholders (individuals and societies) and the governmental authorities responsible because it is a political issue. An example of what may be the threshold criteria for implementing protective measures is shown in Fig. 4. The definition of such criteria must be the result of a political discussion and complies as such fully with the postulated „risk culture".

Within any considered system (e.g. a municipality) the results of the risk assessment are statements about acceptable and non acceptable risks. The latter define the starting point of preventive and mitigative measures.

In order to initiate preventive and mitigative measures it is also helpful to compare the different risks in the valuation process. This is absolutely necessary if not only natural hazards are considered but also risks such as technical risks (nuclear incidents, rail and road accidents), epidemics, or terrorism. Such comparisons are prerequisites to defining priorities for event preparation and for optimizing the allocation of resources.

At the Swiss national level this has been done within the project KATARISK (Disasters and emergencies in Switzerland - Risk assessment from a civil protection perspective, BABS, 2003a) from the point of view of civil defense as an important player in the field of preparedness and coping (2ndnd and 3rd field of action according to Fig. 1). In this project a systematic and comparative investigation of all the hazards selected was performed following a uniform two-stage procedure: risk analysis and risk valuation. Risk valuation considered both society's readiness to pay for damage prevention (marginal costs) and risk aversion to large-scale incidents. Finally, the assessed risks within the range of hazards were compared (cf. BABS, 2003 and BABS, Website).

To summarize: the most important participants and players in the course of risk valuation are the stakeholders (inhabitants) usually represented by politicians who are supported by experts.

3.2 Prevention and preparedness (2nd field of action according to Fig. 1)

Statements about recognized and intolerable risks raise the question "What must be done ?". aThis leads to risk management in the narrow sense and to the starting point of the risk cycle ("preparedness" in Fig. 1).

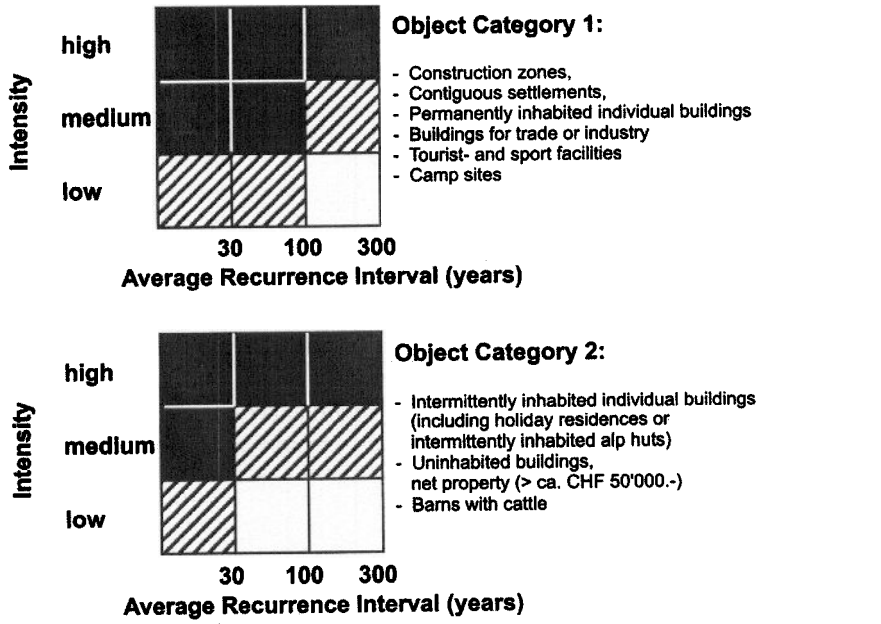

Fig. 4. Thresholds for public interventions depending on politically defined protection goals (examples from ongoing discussions in the Canton of Bern, Switzerland)

Table 1. Hazard and risk analysis / hazard and risk valuation (with respect to a defined system in space and time)

	Analysis *"What could happen ?"*	**Valuation** *"What is allowed to happen ?"*
Hazard	**Hazard Analysis:** *"What natural hazards are threatening ?"* Scientific-technical investigation (type, trajectories, intensities, frequencies, kinds of impact) of the dangerous processes and the effectiveness of possible protective measures	**Hazard Valuation:** *"How are the hazards to be evaluated?"* Classification of the analysis results within a given classification system
	Implementation by expert teams	Implementation by expert teams
	Results: Data (descriptions, maps) about former events, register of event, map of phenomena, data of model calculations, etc.	Results: Intensity maps for different scenarios and probabilities, hazard-index maps, hazard maps with related technical reports
Val	**Analysis of values at risk:** *"What (vulnerable) values are there?"* Investigation (economic, social, ecological, technical) of the objects possibly exposed (kind, material and immaterial values, vulnerability) in the possible effective range of natural hazards	**Valuation of assets at risk:** *"What values (i.e. monetary) and what importance is attributed to the values at risk?"* Classification of the results of the analysis within an explicitly or implicitly defined (by society) valuation system (i.e. protection goal matrix according to Figure 4, or expressed in monetary units); particularly also valuation of human lives in the comparison with property values
	Implementation by expert teams	Implementation by expert teams with respect to the value systems of the "society"
Risk	**Risk Analysis:** *"What is the probability of damage by dangerous natural processes ?"* Analysis of possible damage with consideration of the probability of incidence, developed from the coincidence of vulnerable objects and dangerous processes	**Risk Valuation:** *"What risks are acceptable, what risks are not?"* Valuation of the risks with respect to the risk perception (steered by life experience, value system and standard of living) under consideration of the relationship between risks and opportunities (e.g. land use possibilities of the area in question)
	Implementation by expert teams	Implementation primarily individually (self responsibility), secondarily by delegation to the public and authorities (political decisions)
	Results: Risk maps with related technical reports	Results: Statements about acceptable and non acceptable risks, in consequence definitions of protection goals, maps of protection deficits with related technical reports, possibly preliminary proposals for necessary measures

Prevention

Prevention is the activity of eliminating – or at least minimizing – the risk source(s) identified in the risk valuation steps. This can be accomplished through various measures such as maintenance of protective forests, construction of physical structures (dykes, check-dams, avalanche defense structures, etc.), or land use regulation (e.g. hazard zoning).

Traditionally in Switzerland, and similarly in other mountainous countries, prevention is mainly the duty of forest services on the one hand and of construction services on the other. The forest services generally deal with those processes where forests may contribute to preventing or to reducing hazardous processes. This is particularly the case with slope processes such as snow avalanches, rockfalls, shallow landslides and all the processes in upper torrential catchments that contribute to flash floods, erosion and debris flows. The construction services generally and traditionally deal with the river systems in the valleys and lowlands as well as with the lower parts of mountain torrents, where dams and other big constructions are necessary. In addition, governmental or private operators of utilities (power plants, railways, roads, etc.), build and maintain protective measures.

Most of the participants and players involved in the working out of preventive measures are urban planners, engineers and the corresponding governmental agencies.

Preparedness

Preparedness differs in character from the other components in the risk management cycle since the focus is no longer on the hazard, but rather on the potential damage. Preparedness is the activity of providing an environment in which the vulnerability, damage, and losses are mitigated as much as possible. This includes preparations of all the resources needed to deal with a possible disastrous event. Training initiatives (civil defense, fire fighters, medical services, etc.) and operation of early warning systems are examples of preparedness.

In Switzerland for example, the following integrated partner services are jointly responsible for civil protection:

- "The fire brigades are in charge of rescue, fire fighting and general damage protection, as well as protection and precaution measures in the case of oil, chemical and radiation accidents.
- The health, first aid and emergency medical services provide medical care for the population.
- The technical services ensure that the vital infrastructure remains operational or is restored as rapidly as possible. This includes power, water and gas supply, transport and telematics.
- The police are in charge of maintaining law and order. Both cantonal and municipal police units are deployed to this end." (BABS, Website)

A general condition for smooth and effective intervention in the case of disastrous events is to provide a good information and communication concept. This mainly involves the allocation of responsibilities, in many cases also the preparation of possible contents (e.g. standardized announcements) and last but not least the planning of the related technical aspects.

In disasters every crisis staff at different levels has to deal extensively with media. Therefore it is very important to provide adequate structures and to be prepared to allocate part of the staff to perform this duty.

One aspect that is not yet included in many organizational frameworks is preparation for the securing of evidence. However, this is of great importance because one of the basic approaches in hazard analysis is to make use of experience from earlier events, as shown in Fig. 3, which demands good monitoring of the events. In reality it is quite rare that experts are present when and where hazardous events occur. Therefore it would be desirable that those people who are close to the site of an event would start to monitor the processes as soon as possible and that the experts are alerted immediately to be able to collect data during the event or at least immediately after the event. In the DOMODIS project (HÜBL et al., 2002) an international group of experts has proposed a general framework for the organization of the event documentation. In some regions, like in Switzerland and in the Autonomous Province of Bozen – South-Tyrol

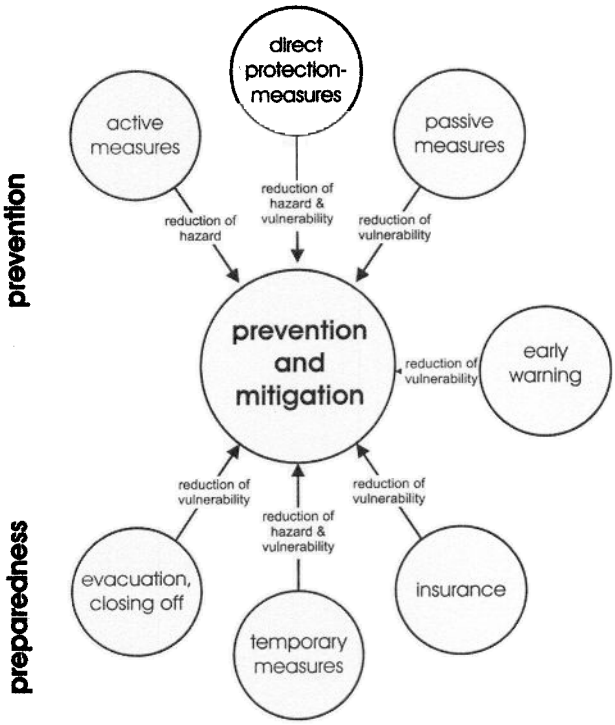

Fig. 5. Preparedness/prevention and mitigation

(Italy), documentation applying the StorMe concept is quite well established (cf. HÜBL et al., 2002).

Since preparedness for event management has a lot to do with organization it largely depends on the political and organizational structure in the different countries. In Switzerland e.g., every municipality generally has a crisis management team which usually consists basically of members of the public authorities and the local emergency services. If a disaster exceeds the capabilities of the affected municipality, neighbouring municipalities provide help. If the dimension of the event is even bigger, then, according to the principle of subsidiarity, the organizations of the canton are mobilized. Last of all, cantonal authorities can request help from the Federal authorities who decide about the mobilization of the army. The army also possesses equipment for temporary disaster prevention and mitigation.

A general concept and framework at the national level, which respects these principles, is being developed within the project KATAPLAN by the Swiss Federal Office for Civil Protection (BABS 2003b). This project concentrates on risks due to major disasters and emergencies such as strong earthquakes, widespread epidemics and large-scale flooding rather than to more common minor incidents. The significance of every risk varies according to planning level (local, regional, cantonal, inter-cantonal and national). Accordingly, KATARISK (BABS 2003a) defines „the relevant risks from the perspective of the different planning levels".

In all the organizations and services there are many participants and players involved. One of the most important tasks in the context of preparedness is to provide regularly recurring training for professionals as well as for reservists and amateurs (e.g. auxiliary fire fighters, ambulance personnel, etc.). Such training must be heavily promoted by the governmental agencies at different levels. However, these duties can be delegated to non-governmental organizations. In Switzerland for example the fire insurance companies that also insure weather-related perils contribute considerably to the financing of such training and also provide instructors and teaching aids. Besides the training of well planned actions and procedures all players must be aware that most disastrous events comprise factors like surprising situations or unexpected developments.

Despite all these organizational measures conducted by governmental bodies at various levels it is also up to each individual to provide mitigation measures under personal responsibility. Beside proper precautions in "house and garden" and beside avoid-

ing threatened places in cases of acute danger, one important provision is to take out insurance. Insurance is one of the most important pillars for regeneration (cf. 4th field of action According to Fig. 1). In some countries (e.g. in most of the Swiss cantons) such insurance is even compulsory. The reason for this is to provide solidarity by means of reasonable premiums. The fact of automatic endorsement of financial risk however leads us to consider some disadvantageous aspects of a high organizational level in risk management as is often the case in highly developed societies. The division of labor also involves division of responsibility and may actually increase people's tendency to delegate responsibility to governmental and administrative bodies. The more society provides regulations, insurance, financial support (subsidies after disasters), the lower the motivation for personal responsibility may be.

The various issues of preparing the management of possible natural disasters involve many participants and players of all different services as mentioned above. This leads to many interactions and therefore requires a comprehensive organization with well defined horizontal (between the different governmental and non-governmental services) and vertical coordination (between the different governmental and administrative decision levels). In many countries the lead is taken by civil protection or similar agencies.

Early warning

All the preparations for event management mentioned above require a great deal of manpower and materials. It is therefore indispensable to set up the organization in multistage degrees of standby. This requires proper systems of early warnings and concepts of alert (cf. KIENHOLZ, 2002).

3.3 Event management (3rd field of action according to Fig. 1)

The best prevention and preparedness do not prohibit the emergence of dangerous processes. If a society really lives the "risk culture" people explicitly have to accept this.

In case of a recognized adverse development of the variable state of the system (cf. Fig. 6, e.g. substantial precipitation for many days, or considerable snowfall, wind and snow drift) early warning procedures must be activated. But very often there is no warning and the coping work has to start immediately.

The aim of all responsive measures is to limit the effects and the duration of a disastrous event. Response includes alerting, rescuing victims and taking care of them, as well as immediate measures to prevent further damage, provisional restoration of important infrastructure and the immediate documenting of events.

Coping

The first phase is characterized by improvisational action by the people who happen to be present. Later, the organized intervention starts and depending on the concrete situation the prepared actions are implemented. The better these actions are prepared, the better are the preconditions to manage the event in an appropriate way. There are, however, always unexpected occurrences and situations. Therefore good preparedness also requires training in how to deal with unexpected situations.

The longer the coping process continues the more important is the well-being of emergency personnel and relief workers.

The coping process shifts seamlessly into the rehabilitation process.

Already in the coping phase the event documentation by local experts who are not directly involved in rescue measures must start in order to collect data about the causes and the course of the hazardous process. This must be done as soon as possible because in the course of the coping measures, such as the removal of debris from roads, which are usually carried out within a few hours, important silent witnesses soon disappear.

The most important participants and players in this phase are the members of the various services involved and the local or regional crisis staff(s). In addition, professional experts also play an important role. They can provide advice with respect to the safety of the rescue teams and other people, as well as make first analyses and give advice about immediate measures and documentation work.

Rehabilitation

In an emergency, destroyed or damaged vital facilities, equipment, and roads have to be repaired as soon as possible to ensure full working order. Of course, this partly means only provisional repair. Also a minimization of follow-up costs (interrupted production, interrupted traffic routes, compensation costs, recovery (health) costs, etc.) must be considered from the beginning.

3.4 Regeneration (recovery and reconstruction, 4th field of action according to Fig. 1)

The main difference between "rehabilitation" and "recovery" is that during the recovery process, provisional solutions are turned into lasting solutions. "The reconstruction of buildings and infrastructure are top priority – as well as the analysis of the disaster. After having dealt with the most urgent problems,

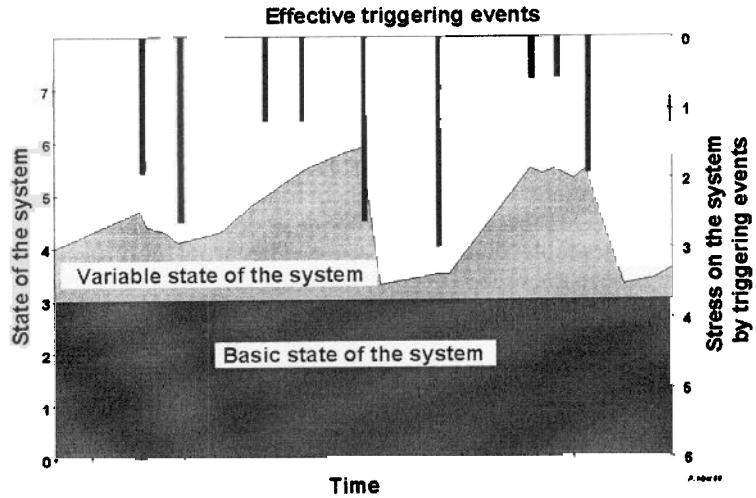

Fig. 6. State of the system and triggering events for dangerous processes (modified according to MANI in ZIMMERMANN et al. 1997) *basic state of the system:* e.g. long-term preconditions, such as the general instability of a slope due to geology, hydrology and topography *variable state of the system:* e.g. short-term variation of slope instability due to change of water level in the soil *triggering events:* e.g. thunderstorm leads to a sudden increase of pore water pressure

every day life returns successively to normal. The main task is to correctly convert the results of the disaster-analysis and to integrate them into planning. Sustainable solutions are to be preferred to easy or cheap solutions" (KRUMMENACHER and WYSS, 2003).

In developed countries in this phase the major operational work such as cleaning and reconstruction can be provided more or less as (significantly) intensified „business as usual" by the inhabitants and organizations of the region, possibly with some external support. An important issue in this phase is compensation by insurance companies, by governments, and by non-governmental relief and aid organizations. In developing countries, however, very often external (international) support is necessary because the local and regional economy is pushed to its limits even in times of no disaster.

First results of disaster analysis "should be available as soon as possible in order to plan reconstruction and to enable correction of previous mistakes or deficiencies. Damages to buildings, infrastructure and cultivated areas show their vulnerability." The situations also have to be analyzed in detail in order to take the right measures during reconstruction. The "evaluation includes the analysis of activities of management units and emergency services to identify possible improvements for future operations" (KRUMMENACHER and WYSS, 2003).

In the longer term vulnerability and protection deficiencies must be analyzed carefully. The bases for this are careful event analyses that include investigations of the causes and of the course of the hazardous process, the behavior and the function of protective measures (standing the test of event management etc.). Depending on the damage and the analyses performed by experts in agreement with the various stakeholders and players, these analyses must lead to

- revision of hazard and risk assessment;
- revision of prevention and mitigation concepts (hazard zoning, directprotection structures, protection work in the source areas, along the possible paths, and in the potential transition and impact areas, preparation of event management)
- consequent implementation of the revised concepts.

Beside measures and actions that can be realized within months or a few years there may also be some long-term investments needed. These may involve changes in regulations (laws, decrees, professional rules, etc.) and in long-term education and instruction of the different stakeholders. In developing countries major issues are general capacity building to deal with natural risks and long-term education on these subjects.

Depending on the concrete situation in the regeneration phase many different participants and players are involved together with the people affected and other stakeholders concerned: hazard and risk experts with different professional background, insurance experts, administrators and political decision-makers at the different levels, professionals for implementation, all inhabitants.

Finally, all the regeneration activities should not only lead to a „status quo ante" but to an improvement of the situation, due to

- learning from the event, and
- utilizing the opportunities provided by the necessity not only to reconstruct but also to undertake new planning, designing and construction.

This should lead to improved prevention and preparedness.

Unfortunately, in many cases passing through the cycle does not start with risk analysis. Very often the beginning is instead triggered by the painful experience of an event.

4. THE RISK MANAGEMENT HALF-CYCLE AND RISK MANAGEMENT SUB-CYCLES

In describing the course of managing natural risks we have used the risk management cycle. This is a tool used to describe the procedures connected with more or less disastrous events that happen from time to time.

An ideal situation however might be one where prevention is done optimally, where no disasters occur or where, through even painful experience, prevention is repeatedly improved. This could be illustrated by a half cycle as shown in Fig. 7. By revision of hazard zoning in the course of the required revisions of urban planning (e.g. at regular intervals of 10–20 years as in Switzerland) a nearly ideal situation may be approached.

The ideal situation without the occurrence of disastrous events, however, is not wholly realistic. It would probably neither be fully desirable. Why is this ? It is necessary that all stakeholders, participants and players in-

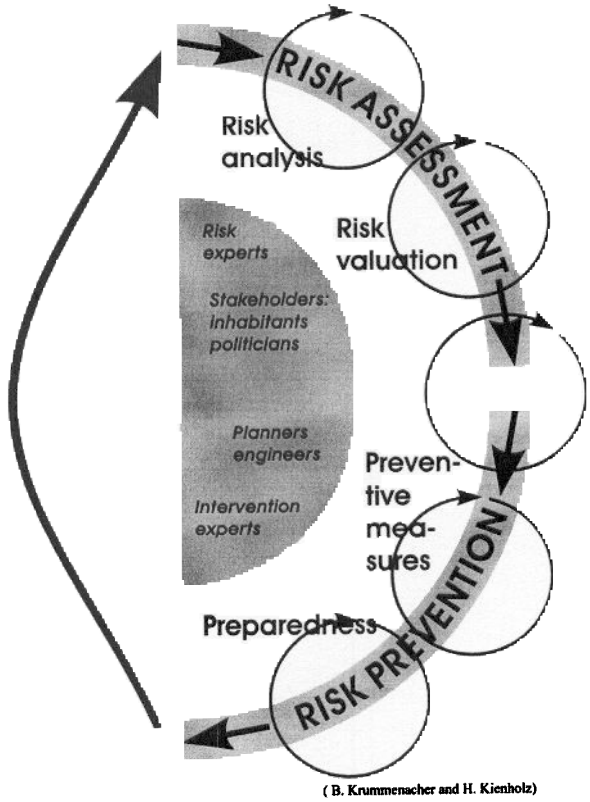

Fig. 7. The risk management half cycle with internal cycles of repeated improvements

volved from time to time are woken up and reminded about what "nature" can do and about the demand for regular rechecking of the prevention and mitigation concepts and measures. Even if it may sound cynical, dealing with natural risk management is also an important business for the different players involved, including experts, politicians, administrators and workers at all levels. This however is not wrong, because natural hazards in the end are unavoidable; the necessity to provide proper risk management is not a matter for discussion. It also goes without saying that all involved participants who deal with natural risks need training and casual confrontation with real events in order to acquire adequate capability to cope with such events.

5. THE RISK MANAGEMENT SPIRAL

While discussing the rehabilitation and especially the regeneration phase, improvements in risk assessment and in prevention and preparedness are postulated. This should consequently lead to improved management, that is, to risk management "at a higher level of performance"! By doing this the risk management cycle turns into an ascendant risk management spiral as illustrated in Fig. 8.

One of the main components of risk management at a higher level of performance is the care and improvement of the coordination between the various players, participants and stakeholders, and therefore also of the communication and information practices in all phases.

Despite all the improvements, despite progress along the ascendant risk management spiral, we still have to be aware that we will never be able to eliminate all risks. An important part

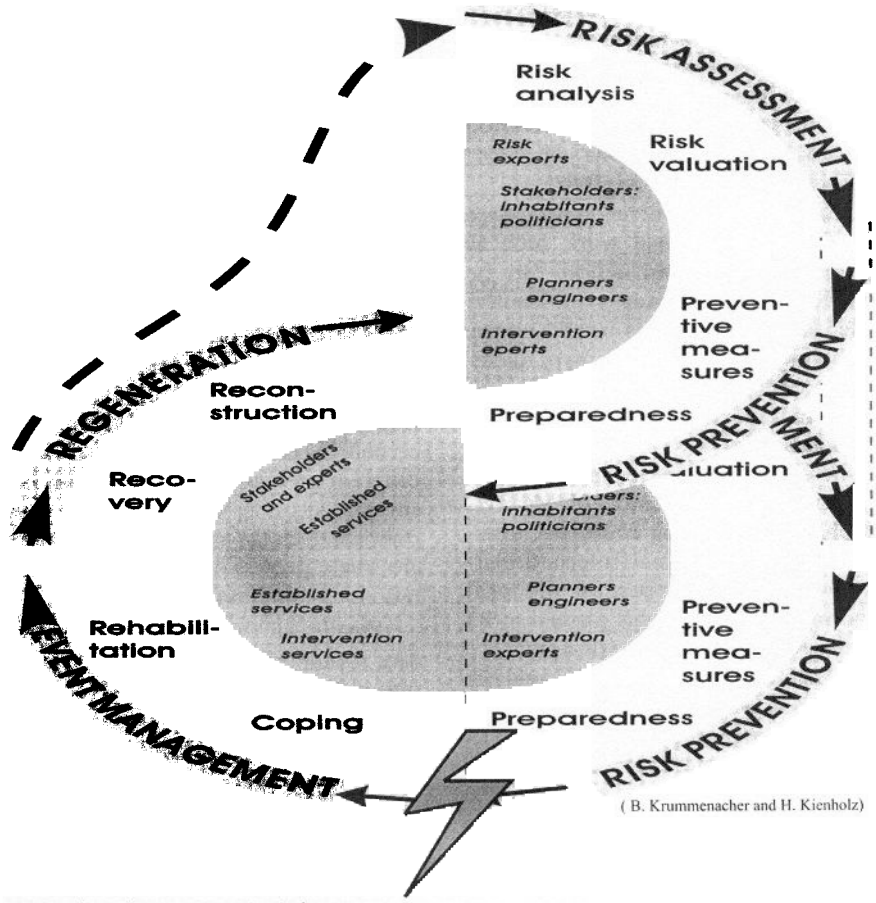

Fig. 8. The risk management spiral

of the postulated "risk culture", as mentioned at the beginning of this paper, is to accept residual and remaining risks. In many cases such risks may be insured.

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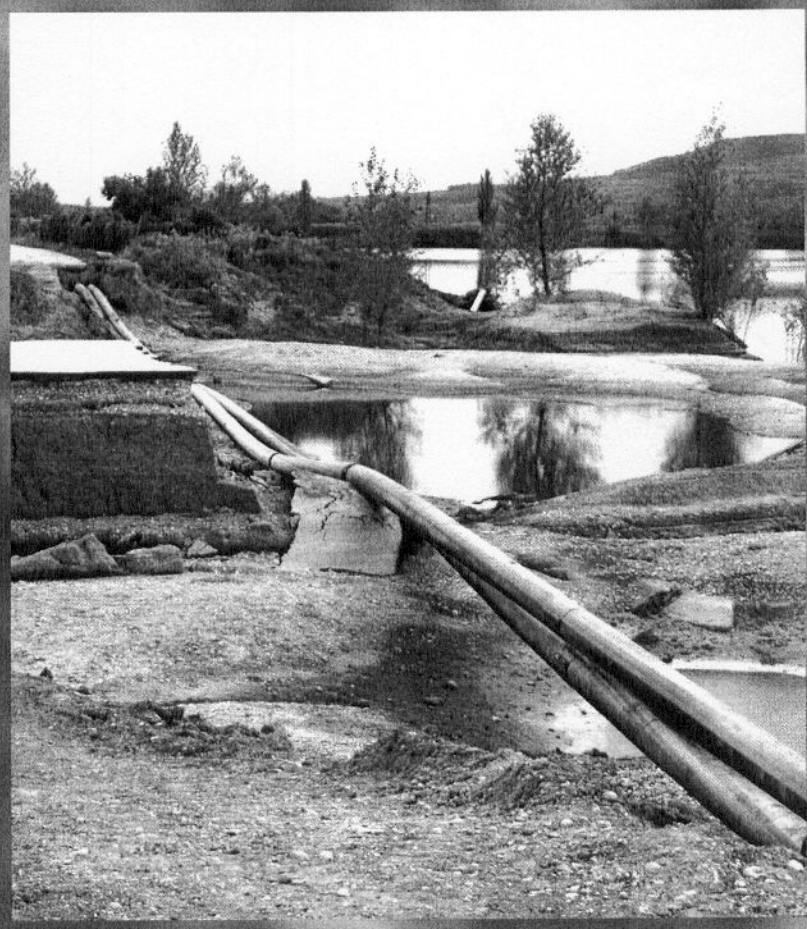
56. JAHRGANG

Österreichische Wasser- und Abfallwirtschaft



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